Economics Department

Organisational Dimensions of Innovation

SANDRINE LABORY

ECO No. 97/7

EUI WORKING PAPERS

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ECONOMICS DEPARTMENT

EUI Working Paper **ECO** No. 97/7

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BADIA FIESOLANA, SAN DOMENICO (FI)

Printed in Italy in April 1997
European University Institute
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Organisational Dimensions of Innovation

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Abstract

This paper examines the theoretical rationale for a new form of organisation appearing in the car industry. This form is characterised by horizontal as well as vertical communication, incentives based on ability rather than on productivity, and a cooperation of the divisions of large corporations. I show in a duopoly model that such horizontal information flows are optimal when the production technology is flexible, that is when there are large factor complementarities. This organisational form enabled Japanese producers to maintain a competitive advantage in terms of time-to-market and rate of product renewal. Therefore, innovation is not only technological, but also organisational.

*I wish to thank Prof. S. Martin, my supervisor, for constructive comments at various stages of this work. Prof. Bianchi (Bologna University) brought precious advice. All remaining errors are mine. Financial support was provided by the Lavoisier grant of the French government.

Contents

1 Introduction

Jacquemin (1996) points to the different dimensions of both competitivity and innovation. In the car industry, competitivity, that is, the ability to gain market share, is determined by the variety, quality and cost of models, together with the time-to-market (time between conception and commercial launch of models) and rate of product renewal. The flexible production system that was initiated by Japanese producers is optimal to produce variety and quality at low cost. This system has been adopted by major producers in the West, yet Japanese producers keep their advantage, especially in terms of time-to-market and rate of product renewal (Fujimoto, 1994). Why ?

The answer lies in the point raised by Jacquemin: innovation is not only technological, but also organisational. Labory (1997) shows that the large

the large re-organisations that have been carried out by automakers since the late 1980s are converging toward a new form of organisation, characterised mainly by horizontal as well as vertical information flows, new incentives, and a certain decentralisation of the large corporation. This form looks like a network, and therefore I call it a N-form, in contrast with the multidivisional form (M-form) outlined by Williamson (1975). Organisational forms of Japanese producers have included this horizontal communication for a long time, and I argue that this provided them with the appropriate framework to turn quickly innovations into commercial success.

2 The N-form

2.1 Definition

The N-form is characterised by multidirectional information flows, incentives based on skills rather than attached to jobs, and decentralisation of strategic local decisions to regional divisions. Given the flexible production system, and the need for producers to "globalise", that is being present in all world markets (to compensate downs in some markets by ups in others) and in all segments (producing the whole range of car models), horizontal information flows are necessary to exploit complementarities. Regional divisions share experience to avoid duplication of effort and exploit their complementary experience. The top hierarchy is flatter for more rapid and more dense information flows, thereby saving time to develop products.

Incentives change, and job rotation replace climbing the hierarchy of the traditional organisational form. Labory (1997) has shown empirically the emergence of the new form, with Honda as a typical example. The next section analyses this form inside the theory of the firm, and section 3 shows its superiority in a duopoly model of multiproduct firms, under the flexible production system.

2.2 Theoretical Rationale for the New Form

In this section, I attempt to provide a theoretical rationale for this new organisation. I show that organisational forms distribute power and authority inside the firm, thereby determining the structure of information flows inside the firm, hence both information processing and agency costs. The production organisation,

- is determined in order to meet performance requirements (e.g. requirements of variety, quality, low time-to-market are best met by flexible production system);
- determines production costs;
- has a corresponding best top level organisation.

The sum of production, agency, and information (processing) costs is the organisational cost, which determines the nature of the superior organisational form.

Economic theory has always been concerned with providing explanations for organisational forms and more broadly for the existence of firms. Three main approaches can be found in the literature. The neoclassical approach sees the firm only from the viewpoint of the market. The firm is a technological blackbox that uses inputs (labour, capital and land) to produce outputs. Coase (1937) in his seminal paper makes a breakthrough in the theory by casting the issue of the reasons for the existence of firms in terms of economies specialised in trade. He argues that entrepreneurial coordination enables firms to reduce the costs associated with market transactions, including information costs arising in the search for equilibrium prices. Williamson takes up Coase's point to develop the transactional approach. He uses concepts to analyse agents' behaviour and decision-making regarding the nature of the transactions to be organised. His perspective is that of resource allocation: technology is, as in the neo-classical approach, given exogenously to the firm.

The third approach is the evolutionary approach (Teece et al., 1994, and Winter, 1995). It is dynamic, and views the firm as a changing organism. Firms' strategies and organisation depends on their

past history and their environment. It is argued that over time firms build capabilities, learn and adapt to their changing environment, thereby accumulating competence.. The survival of firms in industry depends on the competence they accumulate over time, because profitability increases with competence, and survivors are the most profitable firms. This approach has the advantage of being a dynamic approach to the theory of the firm. However, its concepts are quite vague. For instance, the concept of competence encompasses many aspects of firms' capabilities: assets, skills of firms' members, efficiency of incentive systems, extent of scale economies, research, and so on. This raises some problems for its application to the study of alternative organisational forms.

I think that this approach is useful to outline the importance of internal organisation features in determining firms' long-term survival in industries, in addition to their strategic choices. However, it is too vague a concept at firm level, and the theory of the firm can more fruitfully build on transaction cost economics and agency theory.

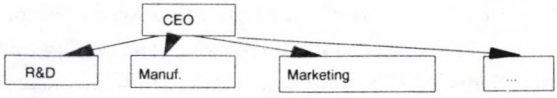
2.2.1 Transactional approach

Williamson argues that agents' behaviour is based on two main principles, namely bounded rationality (individuals' ability to receive, process and stock information is limited and hence the advantage of sequential decision-making made possible in organisation through hierarchies; the key consequence of bounded rationality is that contracts are incomplete), and opportunism (self-interested individuals are controlled and coordinated in organisations thereby enabling some saving on transaction costs arising in markets). Transactions differ according to both the limits they impose on agents' decision-making ability and the room they leave for opportunistic behaviour. The best form of organisation is then determined by the nature of transactions, that is the specificity of assets engaged in the transaction, the uncertainty and frequency of the transactions. The transactional approach therefore explains why internalisation is substituted for the market; it also explains how internal organisation features influence the firm's behaviour and its performance on markets.

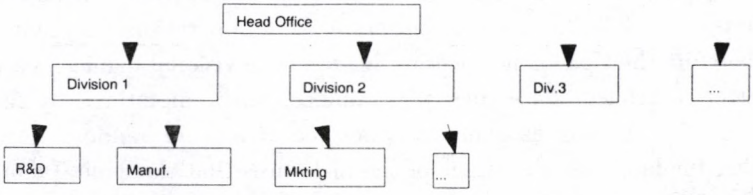
Williamson defines two main forms of organisation, the U-form and the M-form, referring to empirical studies of A. Chandler. The U-form as illustrated in figure 1 has the CEO making both strategic and operational decisions. When the firm's activities grow, the efficiency of this form is limited by the bounded rationality of the CEO, who can no longer handle all decisions, and by the opportunism of managers of functional units who have some scope for pursuing their own interests. This leads to a control loss. Hence the multidivisional form, which firms like Dupont and General Motors were pioneers in adopting in the 1920's, is preferred. The advantage of this form is that decisions are divided: the head office concentrates on strategic issues, while divisional managers make all operational decisions. Therefore the CEO is not overwhelmed, and divisional managers are better controlled, since their performance can be monitored by the head office as long as demand is not too volatile or random. Another fundamental advantage of the M-form is that the capital market is internalised: divisional managers make proposals of investment projects, and the head office allocates funds to the projects with highest expected returns. Divisional managers then compete for funds, thereby having more incentives to exert effort.

Figure 1. Organisational Forms

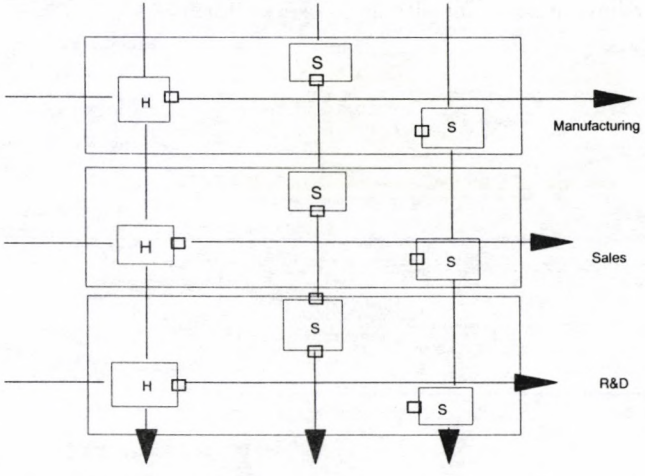
(a) U-form



(b) M-form



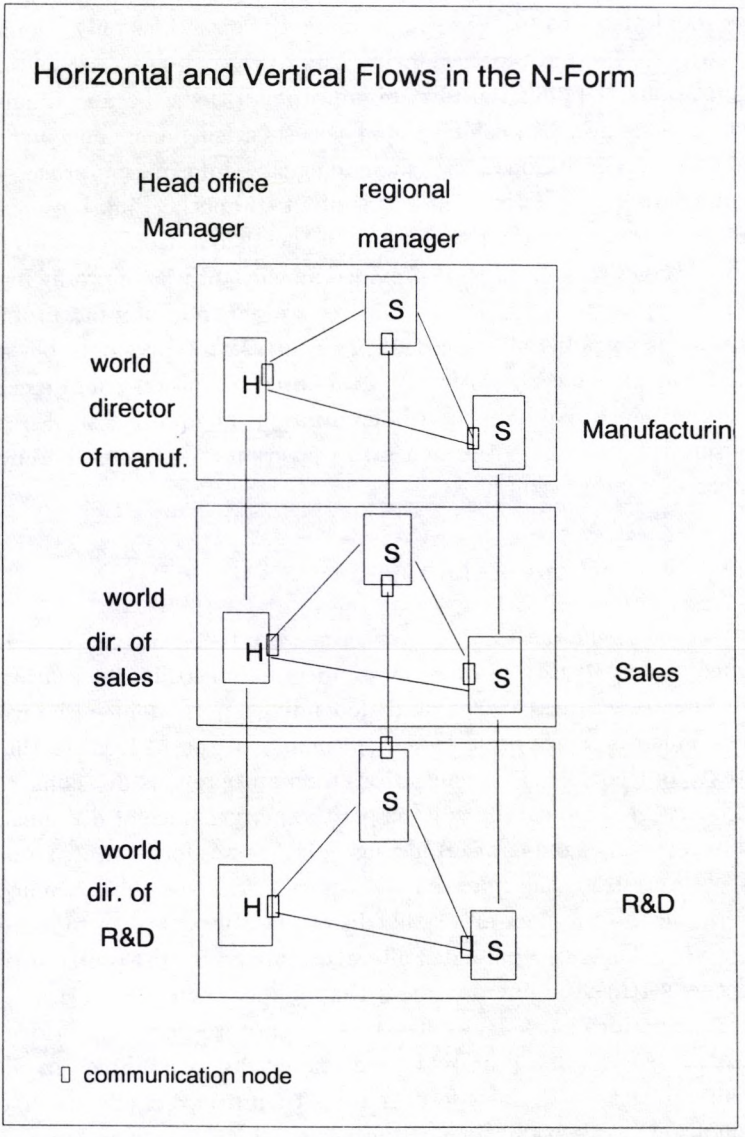
Double Monitoring in the N-form



vertical monitoring

horizontal monitoring

Figure 2.



The difference in organisational forms adopted by firms may be due to their incurring different costs of carrying out activities. Demsetz (1995) argues that it might be useful to distinguish the types of costs arising in both organisations and markets. Thus transaction costs should refer to costs arising in market transactions only. Demsetz suggests the term management costs to refer to costs arising in organisations. I prefer the term organisational costs, because management costs may be misinterpreted as costs arising at management level only. Organisational costs include agency, information processing and production costs. The latter point to another link between firm structure and market structure. In the 1920's, General Motors adopted the M-form because it provided an efficient way of producing different types of cars. That is, GM recognised the potential profit to be made by differentiating cars, in contrast to the single black Ford-T model. Thus the M-form was adopted because it could meet the performance requirements (differentiation) at lowest cost. Firm structure is chosen to optimise a firm's position on market, thereby influencing market structure.

2.2.2 The M-form in the 1990s

In the 1990's, competition is intense and products have to be developed rapidly, because firms' environment is uncertain, fluctuating according to business cycles, and depending on random exchange rates. This raises the issue of the optimality of the M-form in this context. In that form of organisation, with autonomous divisions, it is difficult for the head office to assess the performance of divisions. Bad luck (unexpected changes in consumers' tastes for instance) and lack of effort from the manager are difficult to distinguish. Hence a moral hazard problem arises that has to be solved by appropriate incentives. The principal-agent literature analyses this problem of incentive setting, finding contracts that induce managers to reveal their true performance. By contrast, the greater responsibility (local strategic decisions in addition to operational decisions) given to regional managers in the new form induces them to exert effort, while cooperation between divisions reduces the risk they face and avoids

duplications of effort. Horizontal as well as vertical information flows yield an efficient monitoring. Consequently, agency costs decline.

This outlines one type of organisational cost: agency cost, arising because of asymmetric information between opportunistic firm members, and solved by internal monitoring.

Besides, when the time-to-market of products is a key determinant of market shares, it is important that decisions be made rapidly to react to a move of a rival in the regional market. In the M-form, all such strategic decisions are made at the head office and therefore time is lost in communicating information vertically (as shown on the above figure) to the head and get its feedback. In contrast, the N-form allows regional managers, individually or jointly, to make some strategic decisions, whenever this reduces the time-to-market of products. However, the head office or coordinator of the network makes long-term strategic decisions, such as the choice of entry into new markets, or research as to a fundamental innovation in product or process, such as the electric car (the regional units being in charge with incremental innovations in product or process)[1].

This defines a second important type of cost: information processing costs, due to the bounded rationality of agents.

The major difference between the M- and N-forms lies in the relationship among different parts of the organisation. In the N-form, information flows are both horizontal and vertical, making possible for the co-ordinator (head office) a further delegation of decisions to regional units, while keeping control over them, by appropriate incentives and double monitoring (horizontal and vertical, as shown at the bottom of figure 1). The activities of the co-ordinator office requires less personnel, thereby saving in labour costs. Micromarketing (products targeted at particular groups of consumers, with different products in different regions) is done by each regional units, that is close to markets, hence a higher probability of offering the right

[1]It should be noticed that the N-form concept applies not only to the car industry, but also to high-tech sectors like telecommunications. Thus ATT recently conducted a "strategic desintegration" (Robert Allen, president), by giving more financial autonomy to the divisions, thereby inducing a higher "commercial dynamism", and moving towards the N-form of organisation.

product at the right time. The co-ordinator carries out long-term planning, monitoring of divisions, allocation of resources (personnel, funds, facilities). Therefore, the N-form appears as superior to the M-form because it saves on organisational costs, when the production requirements are variety and low time-to-market. Both agency and information processing costs are lower in the new form. The next section analyses information processing costs more precisely.

2.2.3 Transaction costs revisited

The difference between the multidivisional and the network forms can be summarised as follows.

Table 10. Main differences between the M-Form and the N-Form

M-Form	N-Form
vertical interactions only	Multiple interactions
separation of functions	co-ordination of functions
limited delegation	large delegation
rationale: co-ordination inside firm saves on transaction costs due to bounded rationality and opportunism of firm's members	rationale: concentration on core activities to minimise transaction costs
Integration of suppliers	partnership relationships

The incentives in both forms can be summarised as follows.

Table 11. Incentives associated with the M-Form and the N-Form

M-Form	N-Form
compensation wage and promotion	same compensation
promotion: climbing the hierarchical ladder	promotion: job rotation
limited delegation: low incentives at lower levels (low risk)	large delegation: higher motivation (horizontal risk sharing)
vertical monitoring	monitoring by both horizontal and vertical control
small span of control (many hierarchical levels)	increased span of control

Notice that the cooperation between division in the N-form is induced without additional incentives. As shown in section 3, complementarities in production make it profitable for divisional managers to cooperate.

Therefore, given (a) the new technology (flexible production system, which reduces production costs relative to the rigid production system); and (b) the more intense competition (initially from Japanese producers and recently form Korean producers); it is less costly (and time saving) to delegate more decisions to the regional facilities, to organise horizontal as well as vertical information flows, concentrate on core activities, i.e. to structure as an N-form because this minimises organisational costs.

The relative organisational costs of the U-, M- and N-forms can be summarised in the following table.

Table 12. Organisational Costs

	U-Form	M-Form	N-Form
Agency Costs (monitoring and incentives	zero: no delegation	low in MP* high in FP*	low: double monitoring
Production costs	low in MP high in FP	low in MP high in FP	low in FP
Information costs	very high (entrepreneur handles all knowledge)	high in FP and globalisation	low in FP and globalisation

*: MP = mass production, FP = flexible production; globalisation = presence in all regional markets in all market segments.

When the performance requirements are production of homogenous goods at low cost, mass production is optimal, exploiting large economies of scale. In the U-form, one person handles all information and takes all decisions. Therefore, when the number of markets in which the firm sells increases, the cost of processing information rises rapidly, since there is no delegation. In contrast, the M-form creates one division per product or region, delegating operational decisions to divisional managers, so that information processing costs are lower. As long as demand and factor spillovers between divisions are low, the performance of the divisions can be compared and monitored, and agency costs are low. In short, under mass production total organisational costs are lower in the M-form.

However, when the product is differentiated, and needs to be developed rapidly because of intense competition, the flexible production system carries lower production costs than the mass production system. Further, it has been shown that double monitoring and higher incentives arising in the N-form, due to more responsibility given to divisions and to their cooperation, result in smaller agency costs. The higher delegation as well as the higher number of communication nodes also lower information costs in the N-form relative to the M-form.

Therefore, the sum of production, agency and information costs, that is, the organisational cost, is lower in the N-form with flexible production and globalisation, than in the M-form. An attempt at formalising this point is carried out in the next section.

3 A Duopoly Model of the N-Form

This section formalises the lower agency costs arising in the new form relative to the multidivisional form under the flexible production system.

Faulli-Oler and Giralt (1995) study a principal-agent duopoly where firms are multidivisional and multiproduct. They assume the profits of the divisions are correlated, because of both market spillovers (due to the substitutability of the divisional products) and factor spillovers due to complementarities in production. Their model is interesting because they show how owners can induce their divisional managers to cooperate by setting appropriate incentive schemes. Whether divisions are induced to cooperate depends on the extent of spillovers and other duopoly competition parameters.

They consider two firms, A and B, with two divisions producing one product each. Products are denoted 1 and 2. x_i, $i = 1, 2$, is the total sales of good i. Demand is given by

$$\begin{aligned} p_1 &= \alpha - \beta x_1 - \gamma x_2 \\ p_2 &= \alpha - \beta x_2 - \gamma x_1 \end{aligned} \tag{1}$$

where γ represents market spillovers, and $\alpha > 0, \beta \geq \gamma \geq 0$. The lower γ, the more divisions' products are independent. Costs are assumed quadratic: for

$$j = A, B,$$

$$\begin{aligned} C_{1j} &= M_j x_{1j} + (d+e)x_{1j}^2 - e x_{1j} x_{2j} \\ C_{2j} &= M_j x_{2j} + (d+e)x_{2j}^2 - e x_{1j} x_{2j} \end{aligned} \tag{2}$$

with

$$\begin{aligned} \alpha &> M_A \geq M_B > 0 \\ d &> 0, e \geq 0 \\ e &\neq \gamma \end{aligned}$$

Hence Faulli-Oler and Giralt consider negative market spillover and positive factor spillovers, because complementarity in production is usually associated with product substitutability.

Faulli-Oler and Giralt then assume that the incentive scheme λ is such that each divisional manager maximises the objective function Ω, with

$$\begin{aligned} \Omega_{ij} &= \Pi_{ij} + \lambda j \Pi_{hj} \\ i, h &= 1, 2, i \neq h \\ j &= A, B \end{aligned}$$

The problem with this incentive scheme is that owners do not earn anything, but rather get negative profit: they give each divisional manager all the divisional profit plus part of the other division's profit. Faulli-Oler and Giralt claim that

"*if* $\lambda_j = 0$, *managers are remunerated as if they were the owners of their division, simplifying thus the flow of information across units and making the manager more responsive to the environment*"*(p82).*

What the authors mean is probably that owners base managers' compensation scheme on Ω, giving them a fraction, say σ, of Ω. Then maximising $\sigma\Omega$ is equivalent to maximising Ω.

If the "N-form" hypothesis makes sense it should be possible in this model to find cases where spillovers and other competition's parameters induce divisional managers to cooperate even if this is not directly induced by owners' incentives.

Therefore I model the incentive of divisional managers to cooperate, in the same framework as that of Faulli-Oler and Giralt, but where managers maximise their divisional profit, of which they get a fraction σ and owners get fraction $(1-\sigma)$. I assume demand is given by

$$\begin{aligned} p_1 &= a - bx_1 - b\theta x_2 \\ p_2 &= a - bx_2 - b\theta x_1 \end{aligned} \tag{3}$$

where θ represents market spillovers (degree of substitutability between good 1 and good 2). I prefer this formulation because it distinguishes between the slope of the demand curve and the spillovers, unlike the formulation of Faulli-Oler and Giralt. Costs are given by

$$\begin{aligned} C_{1j} &= M_j x_{1j} + (d+e)x_{1j}^2 - e x_{1j} x_{2j} \\ C_{2j} &= M_j x_{2j} + (d+e)x_{2j}^2 - e x_{1j} x_{2j} \end{aligned} \tag{4}$$

with

$$\begin{aligned} a &> M_A \geq M_B > 0 \\ d &> 0, e \geq 0 \\ e &\neq b\theta \end{aligned}$$

for $j = A, B$.

3.1 Case of autonomous divisions

This is the case of a duopoly where two M-forms with autonomous divisions compete.

Consider the manager of division 1, firm A. He maximises profit

$$\Pi_{1A} = (a - bx_1 - b\theta x_2)x_{1A} - M_A x_{1A} - (d+e)x_{1A}^2 + e x_{1A} x_{2A} \tag{5}$$

The strategic relationships defined by Bulow et al. (1985) are given in this model by:

$$\frac{\partial^2 \Pi_{1A}}{\partial x_{1A} \partial x_{2A}} = e - b\theta \tag{6}$$

If this derivative is strictly positive, the goods in firm A are strategic complements: a division's demand in one market is complementary to the other division's demand in a second market.

$$\frac{\partial^2 \Pi_{1A}}{\partial x_{1A} \partial x_{1B}} = -b \tag{7}$$

This represents the change in the marginal profitability of firm A resulting from being a bit more aggressive when firm B is more aggressive. Since it is negative, firm A regards its product as a strategic substitute to B's. The strategies between firms are strategic substitutes because goods are substitutes.

I consider the case where $e - b\theta > 0$, that is where spillovers between divisions are positive.

The first-order condition is

$$\frac{\partial \Pi_{1A}}{\partial x_{1A}} = a - 2bx_{1A} - bx_{1B} - b\theta x_2 - M_A - 2(d+e)x_{1A} + ex_{2A} = 0$$

Hence the reaction function,

$$2(b+d+e)x_{1A} = a - bx_{1B} - b\theta x_2 - M_A + ex_{2A} \tag{8}$$

by symmetry, other reaction functions are computed as,

$$\begin{aligned} 2(b+d+e)x_{2A} &= a - bx_{2B} - b\theta x_1 - M_A + ex_{1A} \\ 2(b+d+e)x_{1B} &= a - bx_{1A} - b\theta x_2 - M_B + ex_{2B} \\ 2(b+d+e)x_{2B} &= a - bx_{2A} - b\theta x_1 - M_B + ex_{1B} \end{aligned} \tag{9}$$

I first compute the symmetric case where $M_A = M_B = M$.

Then

$$x_{1A} = x_{2A} = x_{1B} = x_{2B}$$

and the reaction functions can be added two by two to get

$$2(b + d + e)x_1 = 2a - bx_1 - 2b\theta x_2 - 2M + ex_2$$

$$2(b + d + e)x_2 = 2a - bx_2 - 2b\theta x_1 - 2M + ex_1$$

Combining the two equations one gets equilibrium output x_1^*,

$$x_1^* = \frac{2(a - M)}{b(3 + 2\theta) + 2d + e}$$

Hence

$$x_{1A}^* = x_{2A}^* = x_{1B}^* = x_{2B}^* = \frac{(a - M)}{b(3 + 2\theta) + 2d + e} \tag{10}$$

Equilibrium divisional output increases when θ reduced, that is when the products become more independent. Similarly, divisional output increases as factor spillovers reduce.

Now replacing x_1 and x_2 by their equilibrium values in the price equations gives equilibrium prices, from which equilibrium profits can be computed. By symmetry, I compute the price and profit of division 1 in firm A.

Prices are given by

$$p_1^* = \frac{[b + 2d + e]\, a + 2b(1 + \theta)M}{b(3 + 2\theta) + 2d + e} \tag{11}$$

and profits

$$\Pi_{1A}^* = (p_1^* - M - dx_{1A}^*)x_{1A}^*$$

$$\Pi_{1A}^{*} = \frac{[b+d+e]\,(a-M)^2}{[b(3+2\theta)+2d+e]^2} \tag{12}$$

If $\theta = 0, d, e = 0$, one finds the usual formula for equilibrium quantities, prices and profits in a Cournot duopoly. Equilibrium divisional profits are lower when products are substitutes. In other words, when divisional managers work independently, their divisional profits decrease with a rise in market spillovers. Divisional profits also fall when factor spillovers increase (e), but by a smaller amount. Low factor and market spillovers are the conditions prevailing in mass production: divisions are defined by product, that is, each division represents a model in the range, so that there is neither factor nor market spillovers (no substitutability between small and large cars, for instance). Divisionalisations like those of GM and Ford before the 1990s are then optimal.

Therefore as market and factor spillovers get larger (which is the case in flexible production, where the divisions produce for the same segments but for different regions), divisional managers may find it profitable to cooperate, since their performance falls if they work independently.

3.2 Case of Cooperating Divisions

This is the case of a duopoly with two N-forms. Divisional managers coordinate their efforts and maximise their joint profit, that is

$$\Pi_c = \Pi_{1A} + \Pi_{2A}$$

Given the assumed demand and cost functions,

$$\begin{aligned}\Pi_c = (a - bx_1 - b\theta x_2)x_{1A} - Mx_{1A} - (d+e)x_{1A}^2 + ex_{1A}x_{2A} + \\ (a - bx_2 - b\theta x_1)x_{2A} - Mx_{2A} - (d+e)x_{2A}^2 + ex_{1A}x_{2A}\end{aligned} \tag{13}$$

assuming unit costs in the two firms are equal.

Managers set x_{1A} and x_{2A} simultaneously to maximise Π_c. First-order conditions are then

$$\frac{\partial \Pi_c}{\partial x_{1A}} = a - 2bx_{1A} - bx_{1B} - b\theta x_2 - M - 2(d+e)x_{1A} + ex_{2A} - b\theta x_{2A} + ex_{2A} = 0$$

$$\frac{\partial \Pi_c}{\partial x_{2A}} = a - 2bx_{2A} - bx_{2B} - b\theta x_1 - M - 2(d+e)x_{2A} + ex_{1A} - b\theta x_{1A} + ex_{1A} = 0$$

These can be written as

$$2(b+d+e)x_{1A} = a - M - bx_{1B} - b\theta x_{2B} - 2(b\theta - e)x_{2A} \qquad (14)$$

$$2(b+d+e)x_{2A} = a - M - bx_{2B} - b\theta x_{1B} - 2(b\theta - e)x_{1A} \qquad (15)$$

Adding divisional output in each firm, one obtains

$$(b(1+\theta)+d)\, x_A = a - M - b(1+\theta)x_B$$

By symmetry,

$$(b(1+\theta)+d)\, x_B = a - M - b(1+\theta)x_A$$

Combining these two equations, equilibrium outputs are computed as

$$x^\star_{1A} = x^\star_{2A} = x^\star_{1B} = x^\star_{2B} = \frac{a-M}{2\,(d+b(1+\theta))} \qquad (16)$$

Output is therefore independent of the factor spillovers parameter e. In order to compare divisional outputs when managers work independently (x_I) and when they cooperate (x_c), I compute the difference:

$$x_c - x_I = \frac{[e - b(1+2\theta)]\,(a-M)}{2\,(d+b(1+\theta))\,(b(3+2\theta)+2d+e)} \geq 0 \qquad (17)$$

This is positive if and only if

$$e \geq b(1+2\theta)$$

since it is assumed that $a > M$, and since the denominator of the fraction is positive. Therefore if factor spillovers are higher than market spillovers, each division produces higher output if they cooperate rather than working independently. I now calculate equilibrium prices and profits in order to compare the two cases. These are,

$$p_1^* = \frac{ad + b(1+\theta)M}{d + b(1+\theta)} \qquad (18)$$

and

$$\Pi_{1A}^* = \frac{d(a-M)^2}{4\,(d+b(1+\theta))^2} \qquad (19)$$

Now let Π_c be the divisional profit from cooperation, and Π_I the divisional profit from independent efforts. Their difference is

$$\Pi_c - \Pi_I = \frac{d(a-M)^2}{4\,(d+b(1+\theta))^2} - \frac{[b+d+e]\,(a-M)^2}{[b(3+2\theta)+2d+e]^2}$$

If $e = 0$, there is no complementarity in production of the two products, and the above difference is equal to

$$\Pi_c - \Pi_I = -b\left[d(3+4\theta) + 4b(1+\theta)^2\right] < 0 \qquad (20)$$

Therefore, if there are no factor spillovers but the products of the two divisions have a certain degree θ of substitutability, it is more profitable for both the managers and the owners to work independently.

If $e \neq 0$, the difference is equal to

$$\Pi_c - \Pi_I = de^2 - b\left[d(3+4\theta) + 4b(1+\theta)^2\right] - 2e\left[2d^2 + 2b^2(1+\theta)^2 + db(1+2\theta)\right]$$

hence for $d > 0$,

$$\Pi_c \geq \Pi_I$$

if and only if

$$P = de^2 - Ae - B \geq 0$$

with

$$\begin{aligned} A &= 2\left[2d^2 + 2b^2(1+\theta)^2 + db(1+2\theta)\right] \\ B &= b\left[d(3+4\theta) + 4b(1+\theta)^2\right] \end{aligned} \tag{21}$$

The roots of P are

$$\frac{-A - \sqrt{A^2 + 4dB}}{2d}; \frac{-A + \sqrt{A^2 + 4dB}}{2d}$$

Hence $P \geq 0$ for e outside the above interval, that is,

$$\begin{aligned} e &\leq \tfrac{-A-\sqrt{A^2+4dB}}{2d} \\ e &\geq \tfrac{-A+\sqrt{A^2+4dB}}{2d} \end{aligned}$$

Since $e > 0$, the result is that

$$\Pi_c \geq \Pi_I$$

if and only if

$$e \geq \frac{-A + \sqrt{A^2 + 4dB}}{2d} \tag{22}$$

for A and B as given above.

Hence the proposition 1.

Proposition 1: Divisional managers find it profitable to cooperate for any given share of profit (incentive) they get if and only if, for A and B given by 21,

$$e \geq \frac{-A + \sqrt{A^2 + 4dB}}{2d}$$

In other words, for a sufficiently high level of complementarity in production of the two divisions, divisional managers find it profitable to cooperate whatever their compensation. The minimum level of factor spillovers for which cooperation is profitable depends on demand parameters, namely the slope of the demand function and the degree of substitutability of the products of each division, as well as the economies of scale (parameter d in the quadratic cost function). The lower the economies of scale, the lower the threshold level of factor spillovers needs to be for cooperation to be induced. Also, the higher the market spillovers between divisions, the higher e needs to be to automatically make cooperation between managers more profitable to them and to the firm.

This provides a theoretical rationale for the cooperation of regional divisions in the new form of organisation appearing in the automobile industry nowadays. Flexible production exploits and increases factor spillovers, hence e increases and cooperation between divisions is more profitable.

Notice that this framework can be used to analyse entry deterrence issues. Schwartz and Thompson (1986) and d'Aspremont and Michel (1990) show that delegation can be used credibly to deter entry. Most models of entry deterrence by holding excess capacity imply that the informed incumbent generally allows entry, because the deterrent is not profitable. By contrast, if the incumbent can duplicate the potential entrant's behaviour by creating a new division, both Schwartz and Thompson and d'Aspremont and Michel show that the incumbent always prevent entry. The former authors then use this argument to explain General Motors' divisionalisation until the mid-1970s, when its activities were very profitable. General Motors had

very independent divisions, that according to Schwartz and Thompson were preventing entry. However, entry of Japanese automakers in the 1970s was not deterred because the latter producers had an absolute cost advantage due to their flexible production technology. Consequently delegation is an important type of commitment that provide an *organisational solution* to the credibility problem of idle capacity models of entry deterrence.

3.3 Duopoly with an N-form and a M-form

In this section, I analyse a duopoly where one N-form and one M-form compete. In the latter form, divisional managers make output decisions independently, maximising their own divisional profit. In the N-form, managers maximise the sum of the divisions' profits. For instance, the M-form with autonomous divisions is General Motors (firm B), and the N-form is Honda (firm A), which has been shown to be a typical case of this model.

In firm A, managers maximise

$$\Pi_c = \Pi_{1A} + \Pi_{2A}$$

yielding reaction functions,

$$2(b+d+e)x_{1A} = a - M_A - bx_{1B} - b\theta x_{2B} - 2(b\theta - e)x_{2A} \qquad (23)$$

$$2(b+d+e)x_{2A} = a - M_A - bx_{2B} - b\theta x_{1B} - 2(b\theta - e)x_{1A} \qquad (24)$$

In firm B, managers maximise divisional profits independently, yielding reaction functions,

$$2(b+d+e)x_{1B} = a - M_B - bx_{1A} - b\theta x_{2A} - (b\theta - e)x_{2B} \qquad (25)$$

$$2(b+d+e)x_{2B} = a - M_B - bx_{2A} - b\theta x_{1A} - (b\theta - e)x_{1B} \qquad (26)$$

Since both divisions in each firm face the same cost conditions, I consider symmetric equilibria, where

$$x_{1A}^{*} = x_{2A}^{*}$$

$$x_{1B}^{*} = x_{2B}^{*}$$

then (23) and (24) as well as (25) and (26) can be added, to get

$$[b(1+\theta)+d]x_A = a - M_A - b(1+\theta)x_B \tag{27}$$

and

$$\frac{b(2+\theta)+2d+e}{2}x_B = a - M_B - b(1+\theta)x_A \tag{28}$$

This reaction functions can be represented as in the following figure, where it is assumed that $M_A = M_B = 1$; $a = 10$; $b = d = e = 1$.

(27) and (28) can be solved for equilibrium outputs:

$$x_{1B}^{*} = x_{2B}^{*} = \frac{a - (2+\theta)M_B + (1+\theta)M_A}{(2+\theta)(4+\theta+e) - 2(1+\theta)^2}$$

and

$$x_{1A}^{*} = x_{2A}^{*} = \frac{(2-\theta+e)a - (4+\theta+e)M_A + 2(1+\theta)M_B}{2[(2+\theta)(4+\theta+e) - 2(1+\theta)^2]}$$

Hence

$$x_{iA}^{*} - x_{iB}^{*} = \frac{(e-\theta)a - (2+\theta-e)M_A - 2M_B}{2[(2+\theta)(4+\theta+e) - 2(1+\theta)^2]}$$

This is positive for e sufficiently large. More precisely, for

$$e > \frac{2(M_A + M_B)}{a + M_A} + \theta$$

equilibrium outputs in firm A's divisions are higher than in firm B, the M-form. This confirms the fact that the flexible production system is advantageous because it exploits factor spillovers between divisions, resulting in their cooperation and higher equilibrium outputs.

Equilibrium prices in division 1 are then, normalising both b and d to 1,[2]

$$p_1^* = \frac{a[2(2+\theta)(4+\theta+e) - 4(1+\theta)^2 - (1+\theta)(4-\theta+e)]}{2[(2+\theta)(4+\theta+e) - 2(1+\theta)^2]}$$

$$+ \frac{(1+\theta)(2-\theta+e)M_A + 2(1+\theta)M_B}{2[(2+\theta)(4+\theta+e) - 2(1+\theta)^2]}$$

Now equilibrium profits can be compared as follows.

In firm A,

$$\Pi_{1A}^* = p_1^* x_{1A}^* - M_A x_{1A}^* - (e+1)(x_{1A}^*)^2 + e(x_{1A}^*)^2$$

since $x_{1A}^* = x_{2A}^*$.

$$\Pi_{1A}^* = (p_1^* - M_A - x_{1A}^*)x_{1A}^*$$

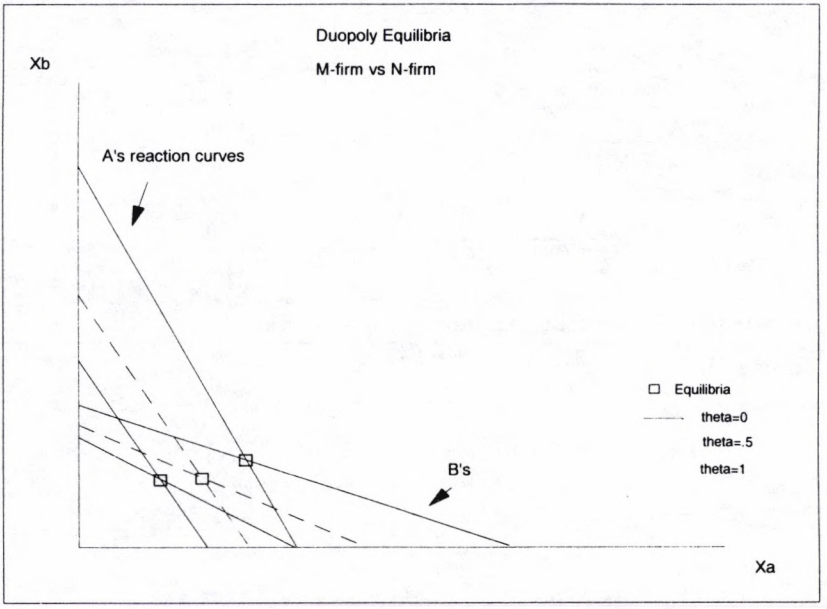
Similarly,

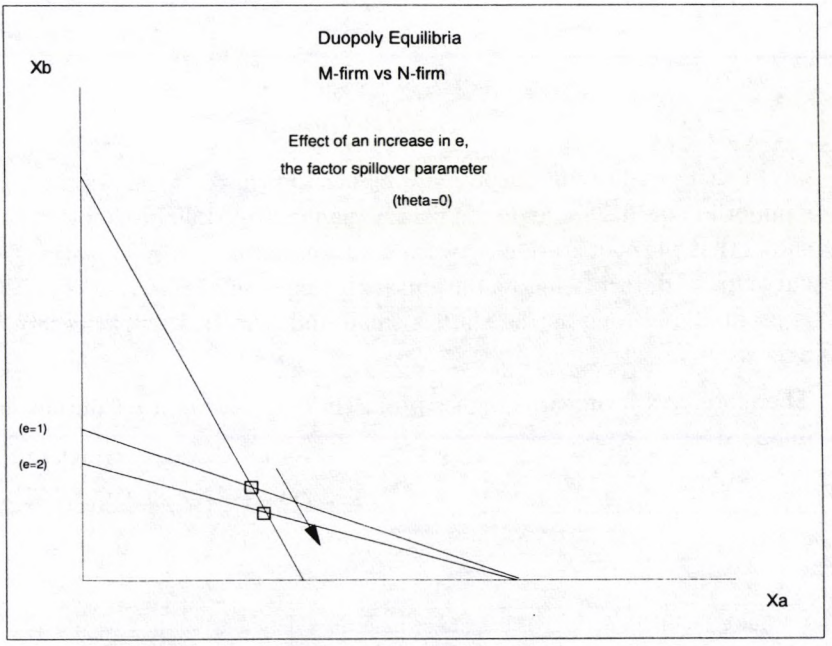
$$\Pi_{1B}^* = (p_1^* - M_B - x_{1B}^*)x_{1B}^*$$

Given that equilibrium outputs are higher in firm A, it follows that equilibrium profits are higher in firm A than in firm B. Figure 6 below shows that the cooperation between divisions shifts firm A's reaction curve upward, increasing its output at the expense of the rival. This is profitable as long as the shift is small and firm B does not react aggressively.

Therefore, a N-form earns higher profit than a M-form in a Cournot duopoly.

[2]Since results in both divisions are symmetric, I only look at the case of one division.





4 Conclusions

The main rationale for the new organisational form is therefore that given the new conditions appearing mainly in the 1980s, namely a new technology and new competitors, it minimises transaction costs. More precisely, the N-form introduces some market incentives that optimise motivation and coordination inside the firm while reducing organisational costs. The increasing intensity of competition makes high variety and low time-to-market key factors of long-term performance, and this is achieved at low cost in the N-form: the flexible production system and larger information flows reduce both information and production costs, while the cooperation between divisions and their frequent interactions lower agency costs (by increasing agents' effort without changing compensation). The key factor for the organisational efficiency of the N-form is that it optimises information flows.

Globalisation means being present in all world markets and all market segments. This raises the complexity of activities, and therefore it is optimal to delegate more decisions to lower levels of the firms' hierarchy, in order for higher levels not to be overwhelmed (too much information to process). Besides, the interactions between functions and between divisions, both horizontally and vertically, provides monitoring at low cost. Hence organisational costs are reduced. These are further reduced by a decrease in the extent of bureaucracy and in the number of hierarchical levels, and by a greater motivation of those executives who are given more responsibilities. Lastly, the concentration on core activities by establishment of long-term relationships with suppliers, but not vertical integration, shifts both some organisational and some R&D costs to suppliers.

The increased delegation of decisions to regional divisions, especially strategic decisions concerning the local market (that maximise the speed of response to local market changes), has a further advantage. The induced higher risks incurred by regional managers is balanced

by an induced cooperation between divisions, sharing R&D and management experiences. The duopoly model developed in this paper shows that such cooperation is induced when factor spillovers (complementarity in the production of the divisions) are high and market spillovers are negative (substitutability of the divisions' products), for given disutility of effort of managers. The model shows that when factor spillovers are high relative to demand spillovers, the N-firm earns higher profit in a Cournot duopoly than a M-firm.

As for the multidivisional form, the "new" form explained in this case study may translate into different characteristics according to the individual firm considered. Such characteristics depend notably on the firm's history. However, the general features should be those defined in this study.

Further research includes the empirical and theoretical analysis of both incentive systems and organisational costs across firms. This would provide further evidence on the evolution of organisational forms, and on the relation between internal organisation and competition.

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